Center Innovation Fund: LaRC CIF

Multi-Functional All BN-BN Composites

Completed Technology Project (2012 - 2013)

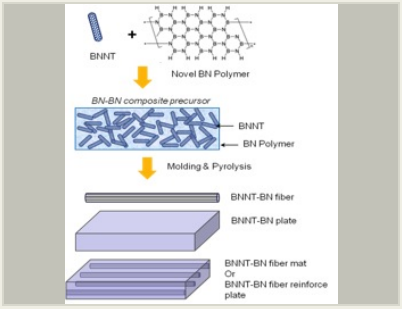
Project Introduction

Development of multifunctional Boron Nitride nanotube-Boron Nitride (BN-BN) composites to provide novel energy transducers, thermal conductors, anti-penetrator/wear resistance coatings, and radiation hardened materials for use in extreme environments. As an analog to carbon fiber reinforced/carbon (C/C) composites, BN-BN composite provides much stronger mechanical integrity and thermal stability due to the wholly BN structure composed of Boron Nitride Nanotubes (BNNT) housed within a BN matrix.

The present technology is aimed at making materials with extremely high thermal stability and conductivity, piezoelectricity, excellent anti-penetrant/wear resistance and radiation hardening capabilities. These properties are expected from the unique molecular structure and morphology of the wholly Boron-Nitrogen system. The B-N bonds are very stable, contributing to the high thermal stability. BN and BNNTs possess high thermal conductivity due to efficient phonon transport. The high neutron absorption cross sections, as well as the low atomic masses of the elements making up the BN-BN system, result in radiation hardening materials with minimal fragmentation from high energy radiation. Cubic boron nitride (cBN) is the second hardest material (Mohs Hardness=9.5, Bulk Modulus~400 GPa) next to diamond (Mohs Hardness=10, Bulk Modulus~440 GPa) (P. Beiss, et al., Group VIII Adv Matls & Tech, 2002). The infusion of BNNTs into BN matrix yields a composite with excellent toughness and enhanced resistance to wear and thermal shock. To fabricate, BN polymeric precursors will be synthesized, then mixed with BNNTs to prepare a homogeneous BNNT-BN polymer composite solution. The BNNT-BN polymer composite solution is then spun to make a fiber/fiber mat or a composite green body. The green bodies are pyrolised at >800°C under an inert gas to facilitate transformation into BN ceramic nanocomposites. The morphology of the ceramic is controlled by adjusting the temperature, time and pressure. To align the BNNTs for maximizing mechanical strength, piezoelectricity and thermal conductivity, the non-woven green bodies can be stretched. The BN-BN composite exhibits hardness, similar to diamond, plus very high mechanical toughness and thermal stability, making it a superb candidate for anti-penetrator/wear resistance coatings. The piezoelectricity is synergized with the matrix BN structure. Electroactive properties are tunable and the material should exhibit excellent radiation protection

Anticipated Benefits

Light weight, anti-penetrating structural materials for a spacecraft, combustion engine components (exhaust nozzles, sensors, actuators), wear resistant breaking system, thermal control coating.



Project Image Multi-Functional All BN-BN Composites

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Center Innovation Fund: LaRC CIF

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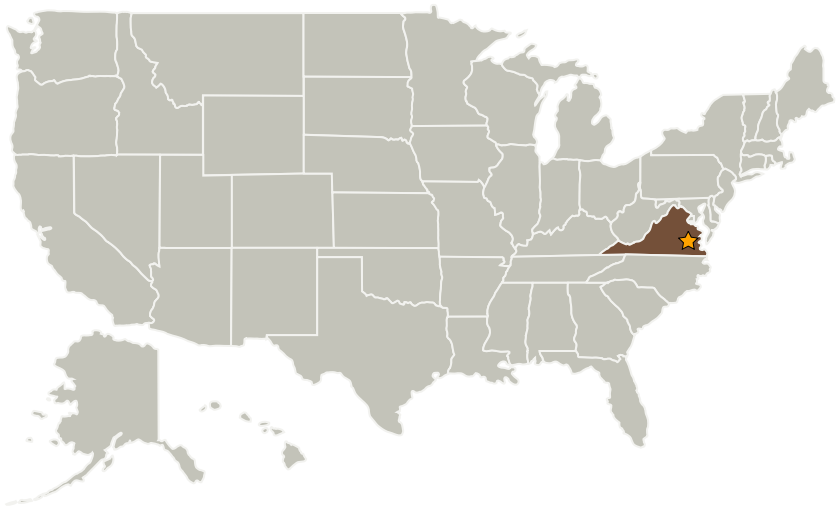
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
National Institute of Aerospace	Supporting Organization	Academia	Hampton, Virginia

Primary U.S. Work Locations
Virginia

Project Management

Program Director:
Michael R Lapointe

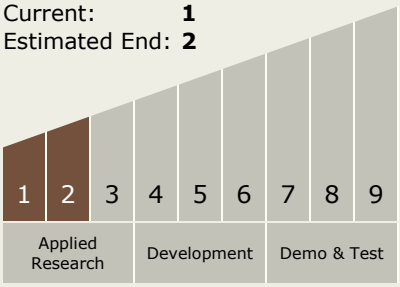
Program Manager:
Julie A Williams-byrd

Project Manager:
Jeffrey A Herath

Principal Investigator:
Jin H Kang

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**

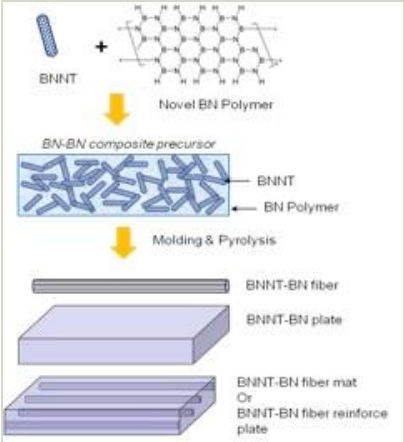


Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.3 Thermal Protection Components and Systems
    - TX14.3.1 Thermal Protection Materials

Images



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Project Image Multi-Functional All BN-BN Composites
(https://techport.nasa.gov/image/1258)